

APPLICATION

of

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for

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on

TABLE TOP REFRIGERATED BEVERAGE DISPENSER

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# TABLE TOP REFRIGERATED BEVERAGE DISPENSER

## BACKGROUND OF THE INVENTION

### Field of the Invention:

The present invention is related generally to beverage dispensing systems  
5 employing a cooling subsystem, and more particularly to a self-contained, table top  
beverage dispenser incorporating a refrigerant-chilled cold plate for cooling the beverage.

### Description of Related Art:

In a large number of restaurants, taverns, pubs, and clubs where beer is sold at a  
10 bar, beer kegs are stored in a cold room where they can be maintained at a reduced  
temperature along with other perishable food items and beverages. These cold rooms are  
typically maintained at a temperature of approximately 40° F. The beer is conducted  
from the cold rooms to serving towers at the bar through plastic tubes or beer lines that  
extend within a thermally insulated jacket, or trunk line. The distance between the cold  
15 room and the tower can be as little as fifteen feet and as great as two hundred feet,  
depending on the layout of the particular establishment. To move the beer through the  
lines, such systems require a pressurization subsystem that forces the beer from the cold  
room down the length of beer line to the beer tower for dispensing. The pressurization  
subsystem introduces a gas such as nitrogen or carbon dioxide into the beverage,  
20 pressurizing the beverage to enable it to be pumped through the beer lines.

As the beer is communicated from the cold room to the dispensing tower, it gains  
heat from the ambient atmosphere and warms to a temperature above the original 40° F.  
Even enveloped in the thermally insulated trunk line, traveling seventy five feet the beer  
in the trunk line can result in a beer temperature increase of 8° F at the end of the trunk  
25 line. Thus, where the length of the beer lines from the cold room to the dispensing  
towers is not minimal, the beer dispensing system will traditionally include one or more

refrigerated glycol chillers that incorporate glycol re-circulating lines of plastic tubing that extend within the thermally insulated trunk line carrying the beer lines. The presence of the glycol recirculation lines can reduce the warming of the beer by five to six degrees, resulting in an end temperature as low as 42° F, or a two degree rise from cold room to the end of the trunk line.

The trunk lines may lead to a counter top supporting cabinetry such that their downstream ends terminate below the counter tops, where they connect with balance lines that extend from the down stream end of the trunk line to the delivery tubes adjacent the respective dispensing valve. In practice the beer flowing from the beer lines, through the balance lines and stainless steel tubes can be expected to further warm from 2° F to 4°F. Accordingly, in the example above beer initially at 40° F in the cold room is warmed to 42° F at the downstream end of the trunk line, and further warmed to approximately 45° F by the time it reaches the dispensing valve.

When beer is charged with a gas such as carbon dioxide to move the beer through the various lines, the gas is entrained or dissolved in the fluid and resides in a stable state for temperatures below or at approximately 30° F. That is, the gas does not bubble out of the fluid but is carried by the fluid and gives the beverage its distinctive effervescence when consumed. However, as the temperature of the beer rises above 30° F, absent an increase in pressure on the system, the gas gradually becomes increasingly unstable and begins to bubble or foam out of the flowing beer. Further warming of the beer increases the foaming effect as the gas bubbles coalesce and propagate downstream, and foaming is further exacerbated by disturbances in the beer such as the turbulence generated when the beer is dispensed from the dispensing valve. When beer is warmed to 45°F or more, when exposed to normal ambient room pressure, the gas becomes so unstable and so much foam is generated when it is dispensed through the valves that it can often times cannot be served to patrons. As a result, the beer dispensed through the valve must be discarded as waste resulting in significant erosion of the owner's profit.

In the recent past, the purveyors of beer using systems such as that described above have resorted to the inclusion of jacketed heat exchangers in the beer distribution

systems just prior to the dispensing valves to chill beer to a low temperature at the downstream end of the trunk lines. The heat exchangers are thermally insulated cast aluminum or aluminum alloy cold plates that incorporate stainless steel tubular beer conducting coils for communicating beer from the downstream end of the trunk lines to the upstream  
5 end of the balance lines. Within the cold plates next to the beer conducting coils are a series of coolant re-circulating coils used to remove heat from the beer in a heat exchanger relationship. Typically the coolant used in such systems has been glycol.

The chilled glycol carries heat away from the cold plate and the beer lines within the cold plate in a continuous manner to lower the temperature of the beer entering the  
10 balance lines. If the glycol is chilled to, for example, 28° or 29° F where it enters the cold plate it can be expected that the beer flowing through the cold plate will be chilled to about 29° F. In such case, the beer as it leaves the cold plate will be conducted to the dispensing valve via the balance lines and will be dispensed at about 29° F. At this temperature, the generation of foam can be minimal if attention and care is applied when  
15 the delivery is carried out through the dispensing valve and profits can be preserved.

A system such as that described above is disclosed in United States Patent No. 5,694,787, entitled "Counter Top Beer Chilling Dispensing Tower," issued December 9, 1997 and which the present inventor was a co-inventor. The '787 patent described a glycol recirculating coil unit or basket including elongate tubular glycol inlet and outlet  
20 tube sections having upstream ends connected to an upstream manifold and downstream ends connected to a downstream manifold.

Although the system disclosed in the '787 patent provided for a counter-top chilling and dispensing apparatus, it required the use of a glycol reservoir and glycol pump which take up significant space and require proper maintenance for efficient  
25 operation.

A need therefore exists for a tabletop chilled beverage dispensing system which is compact, easy to maintain and does not require the utilization of a glycol reservoir or pump.

## SUMMARY OF THE INVENTION

The present invention is directed to a beverage dispensing system for dispensing chilled beverages comprising a housing with one or more beverage inlet connections extending from said housing and one or more beverage dispensers extending from said housing. A beverage cooling system is positioned within said housing, said cooling system comprising a reservoir containing a supply of refrigerant, a cold plate in fluid communication with said refrigerant reservoir wherein the refrigerant lines extend through said cold plate. The cooling system further includes an accumulator, a compressor, a refrigerant condenser and a thermal expansion valve positioned between said refrigerant reservoir and said cold plate to adjust the flow of refrigerant depending upon the temperature of the cold plate, wherein beverage lines extend between said beverage inlet connections and beverage dispensing outlets, said beverage lines passing through said cold plate in a heat exchange relationship with the refrigerant lines.

An electronic control system is provided for controlling the operation of the beverage cooling system. The electronic control system includes an on/off switch controlling the operation of the beverage dispenser, and a pressure switch controlling the operation of the compressor. A second pressure switch is provided for controlling the beverage evaporator coil, a liquid line coil and a time delay relay. A manual defrost switch is provided for operating a defrost line in the event the cold plate becomes frozen.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a perspective view of the subject invention;

FIGURE 2 is a diagram of the refrigerant cooling system of the subject invention;

FIGURE 3 is a diagram of the electrical control system of the subject invention;

FIGURE 4 is a front view of a beverage line coil basket used in the cold plate in one embodiment of the subject invention; and

FIGURE 5 is an end view of the coil basket shown in FIGURE 4.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The stand alone, self-contained beverage dispenser 1 of the present invention is shown in FIGURE 1. Although the subject invention will be described in the context of the beverage to be dispensed being beer, it is to be understood that the invention is not limited to the dispensing of beer. The dispenser of the subject invention may be utilized to chill and dispense any other beverage that may be desired. Beverage dispensing outlets 10a and b extend out of the front end of housing 14. The beverage dispensing outlets may be beer taps or other such dispensers known to those skilled in the art. A beverage spill tray 16 is positioned beneath the dispensing outlets 10a and b.

Beverage dispenser 1 may be mounted on a counter-top or other support surface. Beverage inlet connections 18 (not shown) are provided on the rear of beverage dispenser 1. The beverage dispenser 1 may be easily installed at the desired location. One need simply run the beverage lines from the beverage supply, i.e. beer keg, to the location for connection to the beverage dispenser unit.

A refrigerant cooling system 20 is contained within the housing 14 so as to provide a self-contained beverage dispenser which does not require a separate glycol chiller and pump as required in prior art systems.

The refrigerant cooling system 20 of the subject invention is shown in FIGURE 2. The cooling system 20 includes receiver 22 which acts as the reservoir for the refrigerant, which is in fluid communication with cold plate 24 via refrigerant line 25. Refrigerant cooling lines extend through cold plate 24 to cool corresponding beverage lines which also extend through cold plate 24. The cold plate utilized is a standard cold plate known to those skilled in the art wherein the beverage and refrigerant lines may be wound within the cold plate to increase the length of the lines positioned within said cold plate. The cooling system 20 also includes accumulator 26, compressor 28 and refrigerant condenser 30. As shown, refrigerant exits the cold plate 24 and flows to accumulator 26 via refrigerant line 27. From the accumulator 26, the refrigerant travels to the compressor 28

via refrigerant line 29. The refrigerant flows from the compressor 28 to the condenser 30 via refrigerant line 31.

The operation of the refrigerant system is described below, in connection with FIGURES 2 and 3.

5       The refrigerant, in a preferred embodiment type 404a is used, enters the compressor 28 at point A as a low pressure gas and is discharged from the compressor as a high pressure gas at point B. It then enters the top of the condenser 30 at point C.

10       The refrigerant is cooled in the condenser, exiting it as a high pressure liquid, and passes through a drier 32(which retains unwanted scale, dirt and moisture) to the liquid line valve 34, which is open whenever the cold plate 24 is warm enough to require cooling, as determined by a pressure switch PSW2.

      The refrigerant, still in a high pressure liquid state, flows through the liquid line valve and enters the receiver tank 22, which serves as a storage tank for the refrigerant at point D.

15       At point E, the refrigerant exits the receiver tank, passes through a sight glass 36 (where bubbles will be observed if the system is low on refrigerant) and encounters the thermal expansion valve 38.

20       A pressure differential is provided across the thermal expansion valve. This valve includes a sensor bulb that measures the degree of superheat of the suction gas exiting the cold plate and expands or contracts to allow the flow of refrigerant to be varied according to need. The refrigerant leaving the thermal expansion valve will be in a low pressure liquid state.

25       At the thermal expansion valve 38 there is also a small equalizer tube 39 connected to the outlet of the cold plate 24. The equalizer tube 38 helps to equalize the pressure between the inlet and outlet side of the cold plate 24.

      After passing through the thermal expansion valve 38, the refrigerant enters the cold plate 24 at point G. As the liquid refrigerant enters the cold plate it is subjected to a much lower pressure due to the suction created by the compressor and the pressure drop across the expansion valve. Thus, the refrigerant tends to expand and evaporate. In

doing so, the liquid refrigerant absorbs energy (heat) from beverage lines within the cold plate 24.

The low pressure gas leaving the cold plate 24 encounters the evaporator valve 40, whose function is to trap refrigerant in the cold plate, thus helping to keep the cold plate cold while it is absorbing heat from the beverage, i.e. beer in a preferred embodiment. From the evaporator valve 40, the gas passes into the accumulator 26, which prevents any slugs of liquid refrigerant from passing directly into the compressor, and continues back to the compressor 28.

The thermal expansion valve 38 mentioned above is used instead of a capillary tube in order to provide improved response to the cooling needs of the cold plate 24.

The electrical control system 50 is illustrated in FIGURE 3. Refrigeration on/off switch SW1 provides power to the entire system by manually depressing the switch. Pressure switch SW2 monitors the refrigerant pressure in the compressor and cycles of the compressor and condenser fan (not shown) when the pressure drops to a predetermined level, 15 psi in a preferred embodiment, and cycles the compressor and fan back on when the pressure reaches a second predetermined level, 30 psi in a preferred embodiment. The pressure switch PSW2 normally will be set to monitor refrigerant pressure with a range in the low pressure side of the compressor and cycles off the compressor and condenser fan (not shown) when refrigerant pressure drops to approximately 10 to 20 psi and cycles the compressor back on at approximately 25 to 30 psi. Pressure switch SW3 monitors refrigerant pressure in the beverage cold plate. When the pressure drops to a predetermined level, approximately 62-65 psi in a preferred embodiment pressure switch SW3 cycles off the beverage evaporator coil, liquid line solenoid coil and time delay relay TM-1. When the refrigerant pressure rises to a second predetermined level, approximately 72-75 psi in a preferred embodiment, the switch SW3 cycles on the beverage (beer) evaporator solenoid coil, liquid line solenoid and the time delay relay TM-1. A push-button defrost switch SW4 is provided to cycle on the hot gas solenoid and cycle off the condenser fan to deliver hot gas to the cold plate should the cold plate become frozen.



Pressure switch SW3 responds to the cold plate 24 temperature by reading the pressure of the refrigerant as it is discharged from the cold plate. When the cold plate becomes warm enough the liquid line valve and the evaporator valve open, thereby allowing refrigerant to flow throughout the system. When the cold plate becomes cool enough these valves will close, trapping most refrigerant in the system but allowing gaseous refrigerant to pump from the accumulator into the compressor. Pumping from the accumulator into the compressor extends the life of the compressor by preventing it from having to start against a high pressure differential.

The time delay relay TM-1 causes the liquid line valve and the evaporator valve to remain open for about 10 seconds after the pressure switch SW3 tells them to close. It allows some time for the system to stabilize and prevents short cycling of the compressor.

As shown in FIGURE 2, defrost valve 42 is installed between the compressor discharge tube and the cold plate inlet. A manually operated momentary switch SW4 may be deployed to open the defrost valve, which allows high pressure gas from the compressor to be pumped into the cold plate to thaw it, should it freeze up. To prevent damaging the system, the switch should not be held on for more than two minutes.

The refrigerated beverage system described herein is capable of producing 16 ounce draws on a continual basis at a dispensing of temperature of approximately 29°F based upon a beverage (beer) inlet temperature of 60°F and ambient room temperature of 70°F.

In an alternate embodiment of the invention, the cold plate disclosed in co-pending application Serial No. 10/633,728, for Coil Basket having the same inventor as the subject invention may be utilized. The disclosure of application Serial No. 10/633,728 is hereby incorporated by reference in its entirety.

As show in FIGURES 4 and 5, this cold plate utilizes a beverage line coil basket having a plurality of clips or Y-connectors to take a single inlet line and separate it into a plurality of lines within the cold plate and then reduce the plurality of lines back down to a single outlet line. This allows for greater exposure of the beverage to the refrigerant

lines within the cold plate to maximize the cooling effect of the cold plate on the beverage.

The beverage line circulation system shown in isolation in FIGURES 4 and 5 includes an inlet 50 formed with a connector portion 58 that connects to the beverage line. The inlet 50 further includes a straight pipe portion 60 leading to a cylindrical compartment 65 with a longitudinal axis traverse with the longitudinal axis of the straight pipe portion 60. The cylindrical compartment 65 has an inlet 70 at a centered position on its top surface where the straight pipe portion 60 is welded, such that beverage conducted through the straight pipe portion 60 enters and fills the cylindrical compartment 65. The cylindrical compartment 65 includes two outlets 75 on the bottom surface equally spaced from the central inlet location, and each outlet 75 is welded to an intermediate inlet tubing element 80 such that each intermediate inlet tubing element 80 receives an equal distribution of the beverage flow entering the cylindrical compartment 65. Here, the internal diameter of each intermediate segment 80 is smaller compared with the inner diameter of the straight pipe section 65, and the pair of intermediate segments 80 are preferably arranged in a parallel orientation having conforming curvatures forming an elbow section 88. The transition from a single flow through the straight pipe 60 of the inlet 50 to the pair of intermediate segments 80 constitutes a first stage.

The two intermediate segments 80 at the end of the elbow 88 each terminate in a Y-connector or splitter clip 90 that further divides the flow in each intermediate segment 80 into two smaller, beverage tubes 95. Again, the outlets 98 of the Y-connector 90 are spaced equal distant from the inlet 94 so as to equalize the flow between the two beverage tubes 95. It may be necessary to stagger the location of the Y-connectors 90 in the vertical direction as shown in FIGURE 5 in order to minimize the profile of the basket 10, since the Y-connectors 90 have a width greater than the width of two beverage tubes 95. Placing the two Y-connectors 90 at the same vertical location could unnecessarily widen the basket 10 at that point, so slightly staggering the position of the Y-connectors provides a more compact configuration. The creation of the four beverage lines 95 from the two intermediate segments 80 comprises the second stage.

The four beverage tubes 95 are preferably arranged substantially in a common plane as shown in FIGURE 2, and assimilate into the grouping of the refrigerant conducting tubes. Because the beverage flow has been reduced in two stages, each stage exactly doubling the lines of the previous stage, the resultant flows are equally balanced and each beverage (beer) line is subjected to the same heat exchanging conditions.

The four tubes 95 conducting the beverage converge into two intermediate outlet segments 115 in the same manner as that described for the inlet stage two. That is, two Y-connectors 120 each consolidate two beverage tubes 95 into an intermediate segment 115 having an inner diameter larger than the inner diameter of the heat exchanger tubes 95. The two intermediate outlet segments 115 feed to a cylindrical compartment 120 along a bottom surface thereof, where the inlets 118 to the cylindrical compartment 120 are equally spaced from a centrally disposed outlet 125. The outlet 125 feeds a single straight pipe section 130 leading to beverage outlet 140 of the cold plate with connector portion 142 that carries the end of a beverage line connecting the cold plate with beverage dispensers 10a, b shown in FIGURE 1.

In describing the above beverage circulating system, the term Y-connector or splitter should be interpreted broadly as any fluid dividing member that has either one inlet line and two outlet lines, or two inlet lines and one outlet. Thus, the cylindrical compartments described with respect to the first stage division and consolidation should be considered Y-connectors for purposes of this application. Likewise, clips or other flow dividers that provide a 2 for 1 flow division or flow consolidation are also properly considered Y-connectors.

Each stage of the beverage flow subdivision is preferably accompanied by a reduction in the inner diameter of the downstream tubing, but in a preferred embodiment the cross-sectional area of the two downstream tubing is greater than the cross sectional area of the upstream tubing. This increase in the flow capacity of the downstream tubing results in a slowing of the fluid flow through the cold plate leading to more efficient heat exchange conditions. That is, the resident time for the beverage in the cold plate is

increased and thus the efficiency of the heat exchange is improved when compared to faster moving beverage flow.

While the description above discloses two stages of beverage subdivision forming four discrete beverage tubes 95, the present invention can be expanded to a third stage of subdivision wherein the four beverage tubes are replaced with four transitional tubes that each incorporate a Y-connector at a staggered position with respect to each other to yield eight individual beverage conducting tubes in a manner similar to that described above. Employing eight beverage lines increases the available contact area with the refrigerant conducting lines and can further slow the flow of beverage in the manner described above. However, machining smaller tubes can be more expensive and increase the overall cost of the cold plate. Further, because the walls of the tubing are minimized in the beverage portion of the basket to facilitate heat transfer, smaller tubes may be susceptible to crimping which can block flow and negatively impact heat transfer. Those skilled in the art will recognize that additional stages of subdivision can be provided to allow for additional beverage lines if desired. The ultimate number of beverage lines N can be characterized as  $N=2^S$ , where S is the number of stresses and S is greater or equal to 2.

It is to be understood that the subject invention is not to be limited to the specific embodiment disclosed herein but is to be accorded the full breadth and scope of the appended claims